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REMOVAL OF IMPURITIES IN BAYER PROCESS
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A method and apparatus for the removal of impurities, particularly sodium salts such as sodium sulphate, from Bayer process liquor in an alumina refinery. The process involves dissolving a feedstock of sodium aluminate contaminated with the impurities in a leach tank (12) to form a sodium aluminate solution. The concentrated feedstock is typically derived from a Liquor Burning process (10) or a salting out process (SOP) which incorporates a subsequent calcination step. The concentration of the resultant aluminate solution is controlled at a sufficiently high ionic strength to inhibit dissolution of species of said impurities present in the feedstock, and/or to cause the solubility of the species in the solvent to be exceeded. A concentration within the range 400-500 g/l expressed as sodium carbonate is most effective. The insoluble species are then separated from the sodium aluminate solution in a separating unit (14) and can then be subjected to further processing.

*Removal of sulphates, oxalates after carbonate removed*

**AUSTRALIA**

**PATENTS ACT 1990**

**COMPLETE SPECIFICATION FOR A**

**STANDARD PATENT**

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Standard Complete Specification for the invention entitled:

**REMOVAL OF IMPURITIES IN BAYER PROCESS**

Details of Associated Provisional Applications:

PM5955 filed on 30 May 1994

Details of Parent Application for Divisional Applications:

The following is a full description of this invention, including the best method of performing it known to me:-

REMOVAL OF IMPURITIES IN BAYER PROCESS

The present invention relates to a method for the removal of impurities from Bayer process liquors in an alumina refinery and relates particularly, though not exclusively, to a method for the removal of sodium salts such as sodium sulphate and sodium oxalate from Bayer liquors.

In the Bayer process, bauxite is pressure leached with a liquor containing excess caustic soda. The insoluble material remaining after leaching, referred to as red mud, is separated from the pregnant liquor by decantation and filtration. The clarified sodium aluminate liquor is cooled and seeded to precipitate the dissolved aluminium trihydroxide from the supersaturated solution. The spent liquor is then recycled for further digestion of bauxite.

During digestion, impurities also dissolve in the liquor. The nature and amount of the impurities dissolved is a function of the bauxite, liquor and digestion conditions. After some years, these liquor impurities approach steady state, at levels determined by the various input and removal mechanisms in the refinery. Most impurities enter the process with the bauxite, and exit with the red mud slurry. However, many alumina refineries also include dedicated impurity removal systems, to minimise the adverse effect these impurities have upon the refinery's productivity and product quality.

The majority of the organic and inorganic impurities in Bayer liquors are present as their sodium salts. Hence, they consume caustic. Furthermore, while most impurities are relatively inert in the liquor, a high concentration of these unproductive sodium species in solution affects liquor productivity.

Some of the organic contaminants can have severe effects upon yield and product quality. For this reason, many processes have been developed to control organic impurity levels in Bayer liquors. One of the most effective of these is the Liquor Burning process.

Liquor Burning involves concentrating a small side-stream of Bayer liquor, then drying and calcining this liquor at approximately 1,000°C. This oxidises the organic sodium salts and, by reaction with aluminium trihydroxide, causticises them to form sodium aluminate ( $\text{NaAlO}_2$ ). The sodium aluminate is typically redissolved in spent Bayer liquor and returned to the refinery liquor stream. The Liquor Burning process is the subject of US Patent No. 4,280,987 by Yamada et al. which corresponds to Australian patent No. 523,504. A refinement of the process is the subject of subsequent Australian patent application No. 70264/91.

A number of processes are also in common use to control the organic salt sodium oxalate, an important impurity in many alumina refineries. Since sodium oxalate is sparingly soluble, most of these processes are based upon the common ion effect to induce supersaturation and hence crystallise the compound from solution.

Typically, these processes have no impact on inorganic impurities, of which sodium carbonate, sulphate and chloride are typically the most important. Few techniques exist to control these inorganic impurities. Sodium carbonate can be controlled by causticisation with lime, a process in common use in most alumina refineries. Sulphates and chlorides are chemically stable and very soluble, making their removal difficult, costly, unsafe or environmentally unacceptable.

Sulphate and chloride commonly enter the Bayer liquor

stream from the bauxite and from spent cleaning acids. Chlorides are generally too soluble to be removed economically, however, certain commercial processes have been developed for the removal of sodium sulphate. Most of these processes rely upon increasing the supersaturation of sodium sulphate, forcing it to crystallise from solution. This can be done by evaporation, such as in the salting out process (SOP), extractive crystallisation using organic solvents (Kaiser process), by chilling the liquor, or a combination of these. Alternatively, sulphate can be removed by addition of a heavy metal which forms insoluble sulphates (for example barium, as in the Pechiney process).

These processes suffer from a number of drawbacks, not the least of which are co-precipitation of other species and poor solid/liquid separation, due to the tar-like precipitates which form. These lead to poor efficiency and the loss of valuable materials such as sodium carbonate and sodium aluminate. The Pechiney process suffers from the disadvantage of using expensive, highly toxic and environmentally undesirable barium compounds.

The present invention was developed with a view to providing an improved method for the removal of impurities, particularly sodium salts such as sodium sulphate and sodium oxalate, from Bayer process liquors.

According to one aspect of the present invention there is provided a method for the removal of impurities, particularly, sodium salts such as sodium sulphate, from Bayer process liquor in an alumina refinery, the method comprising the steps of:

dissolving a concentrated feedstock of sodium aluminate contaminated with the impurities, obtained from said Bayer process liquor, in a solvent to form a sodium aluminate solution;

controlling the concentration of the resultant

sodium aluminate solution at a sufficiently high ionic strength to inhibit dissolution of species of said impurities present in the feedstock, and/or to cause the solubility of said species in the solvent to be exceeded;  
5 and,

separating the insoluble species from the sodium aluminate solution which can then be subjected to further processing whereby, in use, said separated species of the impurities can be removed from the Bayer process liquor.

10 In a preferred embodiment, the method further comprises the steps of:

dissolving the separated species in a liquid to form a concentrated solution;

15 controlling the concentration of the resultant solution to inhibit dissolution of less soluble substances that may be present with the separated species; and,

separating the less soluble substances from the solution.

Typically said concentrated feedstock of sodium aluminate  
20 has a low organic impurity content. Advantageously, said concentrated feedstock of sodium aluminate contaminated with said impurities is in the form of a solid, slurry or solution derived from a Liquor Burning process or a salting out process (SOP) which incorporates a subsequent  
25 calcination step. Preferably said sodium aluminate is low in sodium carbonate impurities so that very little sodium carbonate will precipitate from the resultant sodium aluminate solution.

Typically said caustic concentrated feedstock of sodium  
30 aluminate is mixed with a plant liquor from the alumina refinery. Advantageously, spent liquor fortified with the species of impurity to be removed can be used, for example, all or part of the filtrate from alumina seed washing operations to increase the concentration of sodium oxalate

in the resultant solution.

Preferably the concentration of the sodium aluminate solution is controlled within the range 200-800 g/l expressed as sodium carbonate, more preferably in the range 400-500 g/l expressed as sodium carbonate.

Control of the concentration of the resultant sodium aluminate solution is important. Too high a concentration will result in high viscosities, causing filtration, settling and pumping problems. In addition, unacceptable losses of sodium aluminate liquor entrained with the impurity may occur. A final caustic concentration of about 400-500 g/l expressed as sodium carbonate has been found to be most effective, although the method is not restricted to this range. Finally, the solubility of aluminium trihydroxide in the solution should not be exceeded. If necessary, caustic soda may be added to ensure that aluminium trihydroxide does not precipitate from solution.

The high ionic strength of the solution reduces the solubility of any low or moderate solubility species. This prevents any sodium sulphate present in the solid feedstock dissolving. However, sodium chloride will dissolve. The solubility of sodium sulphate and sodium oxalate in the solution will be exceeded and these species, if present in the solvent liquor, will partially precipitate from solution. The precipitate may be disposed of. Alternatively, the method lends itself to further processing to minimise the loss of valuable materials, or to treat the effluent for commercial recovery. A number of these processes may be linked in series to remove other impurities of low or moderate solubility. These linked processes may make use of the purified sodium aluminate solution as before, or use a concentrated solution of one of the inorganic impurities already removed.

According to another aspect of the present invention there is provided an apparatus for the removal of impurities, particularly, sodium salts such as sodium sulphate from Bayer process liquor in an alumina refinery, the apparatus comprising:

means for dissolving a concentrated feedstock of sodium aluminate contaminated with the impurities, obtained from said Bayer process liquor, in a solvent to form a sodium aluminate solution;

means for controlling the concentration of the resultant sodium aluminate solution at a sufficiently high ionic strength to inhibit dissolution of species of said impurities present in the feedstock, and/or to cause the solubility of said species in the solvent to be exceeded; and,

first means for separating the insoluble species from the sodium aluminate solution which can then be subjected to further processing whereby, in use, said separated species of the impurities can be removed from the Bayer process liquor.

In a preferred embodiment said means for dissolving comprises a leach tank in which said concentrated feedstock of sodium aluminate is dissolved in spent liquor from the refinery. Typically said first means for separating comprises a filter unit which separates solid filter cake from a filtrate.

In a preferred embodiment, the apparatus further comprises:

means for dissolving the separated species in a liquid to form a concentrated solution;

means for controlling the concentration of the resultant solution to inhibit dissolution of less soluble substances that may be present in the separated species; and,

second means for separating the less soluble substances from the solution.



In order to facilitate a better understanding of the nature of the invention several embodiments of the method for removal of impurities from Bayer liquors will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a flow diagram of a first embodiment of the method for removal of impurities in Bayer liquors according to the invention;

Figure 2 is a flow diagram of a second embodiment of the method according to the invention;

Figure 3 is a flow diagram of a third embodiment of the method according to the invention;

Figure 4 is a flow diagram of a fourth embodiment of the method according to the invention;

Figure 5 is a flow diagram of a fifth embodiment of the method according to the invention; and,

Figure 6 is a flow diagram of a sixth embodiment of the method according to the invention.

Each of the following examples may embody the method for removal of impurities from Bayer liquors according to the invention, however it will be appreciated that the method of the invention is not restricted to these examples.

**EXAMPLE 1: LIQUOR BURNING FEED WITH SALTING OUT CRYSTALLISER**

In this embodiment, a simple form of the method for removal of impurities is described, with reference to Figure 1, illustrating the basic concept of the invention. A concentrated feedstock of sodium aluminate from a Liquor Burning facility 10 is dissolved in spent liquor from the refinery in a leach tank 12 heated to temperatures between approximately 90°C and 100°C. The mass of Liquor Burning product added to the leach tank 10 is controlled to target a caustic concentration of 400-500 g/l (as  $\text{Na}_2\text{CO}_3$ ) in the resultant sodium aluminate solution. Due to the high ionic strength of the solution the dissolution of any sodium

5 sulphate present in the Liquor Burning product is inhibited, and some of the sodium sulphate and sodium oxalate present in the spent liquor precipitates from solution. The underflow from the leach tank 12 is filtered in a filter unit 14 in order to separate the insoluble species of impurities from the solution, and the liquid filtrate is returned to the refinery circuit. Although filtration is preferred, any solid/liquid separation system can be used.

10 The solid filter cake, which typically contains sodium sulphate and sodium oxalate, is disposed of in a lined dry disposal area. However, in this simplified embodiment of the method for removal of impurities, entrained liquor losses with the filter cake may be unacceptably high.  
15 Furthermore, substantial quantities of insoluble alumina-containing species from the Liquor Burning facility 10 may be discarded with the filter cake.

The filter unit 14 may be any suitable filter for separating the insoluble species from the sodium aluminate solution, for example, a pressure filter. In a pressure  
20 filter the sodium aluminate solution is pumped under pressure through filter cloth, and the insoluble solids are scraped off the filter cloth in a batch process.

#### **EXAMPLE 2: LIQUOR BURNING FEED WITH RECOVERY OF $\beta$ ALUMINA**

25 If loss of alumina-containing species with the filter cake in the method of example 1 is deemed unacceptable, insoluble products from the Liquor Burning facility (such as  $\beta$  alumina) may be recovered and returned to the Liquor Burning facility 10. The method of this example  
30 illustrated in Figure 2 is similar to that of Figure 1, however in this case the solid filter cake from the filter unit 14 is directed to a dissolver tank 16. In dissolver tank 16 the ionic strength of the solution is maintained at a level in which the sodium sulphate dissolves, but poorly

soluble alumina-containing compounds do not. Any sodium oxalate present in the filter cake will also not redissolve, as the ionic strength is too high. The underflow from dissolver tank 16 is directed to a two stage filter 18  
5 for separating the solid alumina-containing compounds from the solution.

The first stage filtrate, a concentrated sodium sulphate solution, is processed further or is pumped to a sulphate pond for disposal. The solid filter cake is rinsed with  
10 water, such as hot condensate, to wash out any entrained liquor, and the washed filter cake is then returned to the Liquor Burning facility 10. Rinsing of the filter cake is intended to minimise recycling of sulphate back to the  
15 Liquor Burning facility 10. The second stage filtrate after washing is collected and returned to the dissolver tank 16, where it is used for the sodium sulphate dissolution step.

The two stage filter 18 is preferably of the kind having two vacuum stages, for example, a drum or belt filter. In  
20 a drum filter a fine mesh filter cloth or felt material is supported on a rotatable drum, and a vacuum is maintained within the drum so that liquid in the solution is drawn through the filter cloth and collected inside the drum. The solid filter cake can be scraped off the outer surface  
25 of the drum. In the first stage the solid filter cake is separated from the liquor which is collected inside the drum, from where it is pumped out for disposal or further processing. In the second stage, the solid filter cake on the outer surface of the drum is rinsed with water, and the  
30 filtrate is again collected inside the drum, and in this case returned to the dissolver tank 16.

### EXAMPLE 3: RECOVERY OF $\beta$ ALUMINA AND PURE SODIUM SULPHATE

Further processing steps may be added to the method described in Example 2 and illustrated in Figure 2, for

example, for recovering a purified commercial grade sodium sulphate. The flow diagram of Figure 3 is similar to that of Figure 2 but incorporates an additional processing step for recovering purified sodium sulphate. In addition, this embodiment of the method further minimises alumina losses.

The slurry produced in the dissolver tank 16 is fed to a second filter unit 20, similar to the first filter unit 14 described above. The solid filter cake from the second filter unit 20, which comprises insoluble alumina species and sodium oxalate, is returned to the Liquor Burning facility 10. The filtrate from the filter unit 20, a concentrated sodium sulphate solution, is fed to a sodium sulphate crystalliser 22, together with some of the purified sodium aluminate liquor from the first filter unit 14. This supersaturates the sodium sulphate solution in the sulphate crystalliser 22.

The underflow from the sulphate crystalliser 22 is then directed to the two-stage filter 18. A purified sodium sulphate is recovered by filtration and washed on the second stage of the two-stage filter 18. The second stage filtrate or washings are returned to the dissolver tank 16 as before. The first stage filtrate, containing purified sodium aluminate and sodium sulphate is returned to the leach tank 12. To improve yield, crystal morphology and purity, some of the pure sodium sulphate which is recovered is returned as seed to the sulphate crystalliser 22.

An alternative method for supersaturating the sodium sulphate filtrate from filter unit 20 would be to concentrate and crystallise the sodium sulphate solution in an evaporative crystalliser. This would obviate the need to recycle any of the leach tank filtrate. Alternative means of supersaturating the liquor in the sodium sulphate crystalliser 22 may also be employed. For example, the chilling or extractive crystallisation processes mentioned

above could be used.

It may also be possible to improve conversion of sodium carbonate to sodium hydroxide by including a causticisation step (not illustrated) after filter unit 20 by the addition of slaked or raw lime.

#### **EXAMPLE 4: OXALATE REMOVAL FOR LOW SULPHATE LIQUOR**

In alumina refineries where the sodium sulphate concentration is low, the method of invention can be used to aid oxalate removal as illustrated in Figure 4. The slurry underflow from leach tank 12 is directed to the alumina refinery's existing oxalate removal system 22, raising the oxalate super saturation. The oxalate removal system 22 separates the sodium oxalate from the slurry, and the sodium oxalate is then removed for destruction (eg. in the Liquor Burning facility) or disposal. The purified slurry is returned to the refinery for further processing.

#### **EXAMPLE 5: OXALATE AND SULPHATE REMOVAL**

In this example, illustrated in Figure 5, the sulphate removal process of Figure 1 is linked in series with the oxalate removal process of Figure 4. The purified sodium aluminate liquor from the filter unit 14 is used to assist in the removal of sodium oxalate in the refinery's oxalate removal system 22, by increasing the oxalate super saturation.

#### **EXAMPLE 6: USE OF SOP/KILN AS FEED**

In the example illustrated in Figure 6, a different source of concentrated sodium aluminate feedstock is employed. In this case, the clinker from a salting out process (SOP) unit 24 is mixed with bauxite in a mixer 26 and calcined in a kiln 28 to yield a clinker containing sodium aluminate. This is a process which has been used commercially and yields a clinker which is low in sodium carbonate.

In this example, the clinker is ground in a grinding unit 30 with spent liquor from the refinery to produce a slurry in which the liquor caustic concentration is in the range of 400-500 g/l. A slurry containing sodium sulphate, sodium oxalate and red mud is produced, which can then be filtered in filter unit 32 and the filter cake disposed of in a dry residue disposal area.

#### LABORATORY TEST RESULTS

Liquors of high and moderate sodium sulphate concentration were prepared from typical Bayer spent liquors. The liquors were deeply evaporated and mixed with additional hydrate to give an alumina to "recoverable" soda molar ratio of 1.14. This mixture was calcined at 1000°C to simulate a liquor burning operation (Unit 10 of Figures 1 through 5). The simulated liquor burner product was then mixed with some of the spent liquor to obtain a leach tank discharge (Unit 12 of Figures 1 through 5). By varying the ratio of liquor burning product to spent liquor, the behaviour at both moderate and high leach tank caustic concentrations was examined.

The resultant slurry was separated in a centrifuge to simulate the solid/liquid separation process (Unit 14 of Figures 1 through 5), and the centrate analysed to determine the sodium sulphate not recovered by separation. The recovery of sodium sulphate was then calculated by difference. The concentrated sludge obtained from the separation step was dissolved in water to simulate the action of the dissolver tank (Unit 16 of Figures 2 and 3).

In the case of a moderate leach tank concentration (400 g/l), the recovery of sodium sulphate was 72% for the high sodium sulphate case and 31% for the moderate sulphate concentration case. For the tests simulating high leach tank caustic concentrations (500 g/l), the recovery was 82% and 73% respectively.

The laboratory tests indicate that by operating the leach tank at an optimal caustic concentration (high enough to suppress sodium sulphate solubility and low enough to enable sufficient solids separation) greater than 70% of the sodium sulphate can be recovered and removed from the process.

**TEST 1 - HIGH SODIUM SULPHATE LEVELS**

Sample	Mass of LB product (g)	Volume of spent liquor	Caustic (g/l as $\text{Na}_2\text{CO}_3$ )	C/S	A/C	$\text{Na}_2\text{SO}_4$ (g/l)	Recovery (%)
Spent liquor	-	-	220.6	0.831	0.445	55.4	-
Leach Tank discharge Test 1A	60	149.4	399.8	0.913	0.681	23.8	72%
Test 1B	101	149.4	497.1	0.957	0.771	19.1	82%

**TEST 2 - MODERATE SODIUM SULPHATE LEVELS**

Sample	Mass of LB product (g)	Volume of spent liquor	Caustic (g/l as $\text{Na}_2\text{CO}_3$ )	C/S	A/C	$\text{Na}_2\text{SO}_4$ (g/l)	Recovery (%)
Spent liquor	-	-	252.8	0.821	0.450	26.2	-
Leach Tank discharge Test 2A	47.3	150.1	392.7	0.878	0.662	25.3	31%
Test 2B	82.8	150.1	481.1	0.934	0.730	11.6	73%

The amount of liquor entrained in the solids will depend on the separation method. This will be dependant upon the actual implementation. However, liquor losses of this type can be minimised by using the method and apparatus of the preferred embodiment of Figure 3.

Now that several examples of the method for the removal of impurities from Bayer Liquors have been described, it will be evident that the preferred method for removal of sodium sulphate has a number of advantages over conventional sulphate removal processes, including the following:

(i) Very little sodium carbonate is lost as solid with the sodium sulphate because the sodium aluminate feedstock used in the process is typically low in sodium carbonate. Processing costs are therefore significantly lower.

(ii) A much higher proportion of sodium sulphate can be removed. The preferred method includes an additional sulphate input stream (spent liquor to leach tank), therefore presenting more sulphate for removal.

(iii) Because the sodium sulphate can be removed in a much purer form, (ie, less sodium carbonate present), there is more opportunity for downstream processing, such as further purification of sodium sulphate via a re-crystallisation process. A purer form of sodium sulphate could then be commercially exploited (for example, for use in a Kraft paper mill).

(iv) Solid-liquid separation is considerably more efficient. Since this process specifically avoids concentrating the organic sodium compounds they do not co-crystallise with the inorganic impurities. The usual tarry precipitate is avoided, and the slurry can be filtered more efficiently.

Numerous variations and modifications will suggest themselves to persons skilled in the appropriate arts. For



example, the method also lends itself to the removal of other sodium salts and inorganic impurities, in addition to those already described. Further processing steps may be added to the examples illustrated, without departing from the basic inventive concepts. For example, the recovered sodium sulphate could be converted to sodium hydroxide, which could then be re-injected back into the bayer liquor. Alternatively, the sodium sulphate could be converted to a more inert form which could then be deposited in a location that would not require special security to prevent back contamination of the bayer liquor. All such variations and modifications are to be considered within the scope of the present invention, the nature of which is to be determined from the foregoing description.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A method for the removal of impurities, particularly, sodium salts such as sodium sulphate, from Bayer process liquor in an alumina refinery, the method  
5 comprising the steps of:

dissolving a concentrated feedstock of sodium aluminate contaminated with the impurities, obtained from said Bayer process liquor, in a solvent to form a sodium aluminate solution;

10 controlling the concentration of the resultant sodium aluminate solution at a sufficiently high ionic strength to inhibit dissolution of species of said impurities present in the feedstock, and/or to cause the solubility of said species in the solvent to be exceeded;  
15 and,

separating the insoluble species from the sodium aluminate solution which can then be subjected to further processing whereby, in use, said separated species of the impurities can be removed from the Bayer process liquor.

20 2. A method for the removal of impurities from Bayer process liquor as defined in claim 1, further comprising the steps of:

dissolving the separated species in a liquid to form a concentrated solution;

25 controlling the concentration of the resultant solution to inhibit dissolution of less soluble substances that may be present with the separated species; and,

separating the less soluble substances from the solution.

30 3. A method for the removal of impurities from Bayer process liquor as defined in claim 1 or 2, wherein said concentrated feedstock of sodium aluminate has a low organic impurity content.

4. A method for the removal of impurities from Bayer process liquor as defined in claim 3, wherein said concentrated feedstock of sodium aluminate contaminated with said impurities is in the form of a solid, slurry or solution derived from a Liquor Burning process or a salting out process (SOP) which incorporates a subsequent calcination step.

5. A method for the removal of impurities from Bayer process liquor as defined in claim 4, wherein if said sodium aluminate is not low in sodium carbonate impurities so that sodium carbonate precipitates from the resultant sodium aluminate solution, the method further comprises a lime causticisation step after the step of separating the less soluble substances whereby the sodium carbonate is converted to sodium hydroxide.

6. A method for the removal of impurities from Bayer process liquor as defined in claim 4, wherein said caustic concentrated feedstock of sodium aluminate is mixed with a plant liquor from the alumina refinery.

7. A method for the removal of impurities from Bayer process liquor as defined in any one of claims 1 to 6, wherein the concentration of the sodium aluminate solution is controlled within the range 200-800 g/l expressed as sodium carbonate.

8. A method for the removal of impurities from Bayer process liquor as defined in claim 7, wherein the concentration of the sodium aluminate solution is controlled within the range 400-500 g/l expressed as sodium carbonate.

9. A method for the removal of impurities from Bayer process liquor as defined in claim 8, further comprising the steps of:

supersaturating the solution of the separated species left after said step of separating the less soluble substances; and

5 separating the supersaturated species from the supersaturated solution so as to obtain a purified form of said separated species.

10. An apparatus for the removal of impurities, particularly, sodium salts such as sodium sulphate from Bayer process liquor in an alumina refinery, the apparatus  
10 comprising:

means for dissolving a concentrated feedstock of sodium aluminate contaminated with the impurities, obtained from said Bayer process liquor, in a solvent to form a sodium aluminate solution;

15 means for controlling the concentration of the resultant sodium aluminate solution at a sufficiently high ionic strength to inhibit dissolution of species of said impurities present in the feedstock, and/or to cause the solubility of said species in the solvent to be exceeded;  
20 and,

first means for separating the insoluble species from the sodium aluminate solution which can then be subjected to further processing whereby, in use, said separated species of the impurities can be removed from the  
25 Bayer process liquor.

11. An apparatus for the removal of impurities from Bayer process liquor as defined in claim 10, said means for dissolving comprises a leach tank in which said concentrated feedstock of sodium aluminate is dissolved in  
30 spent liquor from the refinery.

12. An apparatus for the removal of impurities from Bayer process liquor as defined in claim 10 or 11, the apparatus further comprising:

means for dissolving the separated species in a

liquid to form a concentrated solution;

means for controlling the concentration of the resultant solution to inhibit dissolution of less soluble substances that may be present in the separated species;

5 and,

second means for separating the less soluble substances from the solution.

13. An apparatus for the removal of impurities from Bayer process liquor as defined in claim 12, wherein said  
10 second means for separating comprises a multi-stage filter unit for separating the less soluble substances as a solid filter cake from the filtrate in a first stage, and then subsequently washing the solid filter cake to remove any entrained liquor, and wherein the filtrate from the second  
15 stage is returned to the means for dissolving the separated species.

14. An apparatus for the removal of impurities from Bayer process liquor as defined in claim 12, wherein both  
20 said first and second means for separating comprise a filter unit which separates solid filter cake from a filtrate.

15. An apparatus for the removal of impurities from Bayer process liquor as defined in claim 14, further comprising:

25 means for crystallising the filtrate from said filter unit so as to form a supersaturated solution of sodium sulphate; and,

third means for separating a purified sodium sulphate from the concentrate of the crystallising means.

30 16. An apparatus for the removal of impurities from Bayer process liquor as defined in claim 15, wherein said third means for separating the purified sodium sulphate is also a two-stage filter unit as defined in claim 12, and

wherein the filtrate from the first stage is returned to the leach tank.

17. An apparatus for the removal of impurities from Bayer process liquor substantially as herein described with  
5 reference to and as illustrated in any one or more of the accompanying drawings.

18. A method for the removal of impurities from Bayer process liquor substantially as herein described with  
10 reference to and as illustrated in any one or more of the accompanying drawings.

Dated this 29th day of May, 1995

WORSLEY ALUMINA PTY LTD  
By Its Patent Attorneys

15 GRIFFITH HACK & CO.  
Fellows Institute of Patent Attorneys of Australia.

ABSTRACT

A method and apparatus for the removal of impurities, particularly sodium salts such as sodium sulphate, from Bayer process liquor in an alumina refinery. The process involves dissolving a feedstock of sodium aluminate contaminated with the impurities in a leach tank (12) to form a sodium aluminate solution. The concentrated feedstock is typically derived from a Liquor Burning process (10) or a salting out process (SOP) which incorporates a subsequent calcination step. The concentration of the resultant aluminate solution is controlled at a sufficiently high ionic strength to inhibit dissolution of species of said impurities present in the feedstock, and/or to cause the solubility of the species in the solvent to be exceeded. A concentration within the range 400-500 g/l expressed as sodium carbonate is most effective. The insoluble species are then separated from the sodium aluminate solution in a separating unit (14) and can then be subjected to further processing.

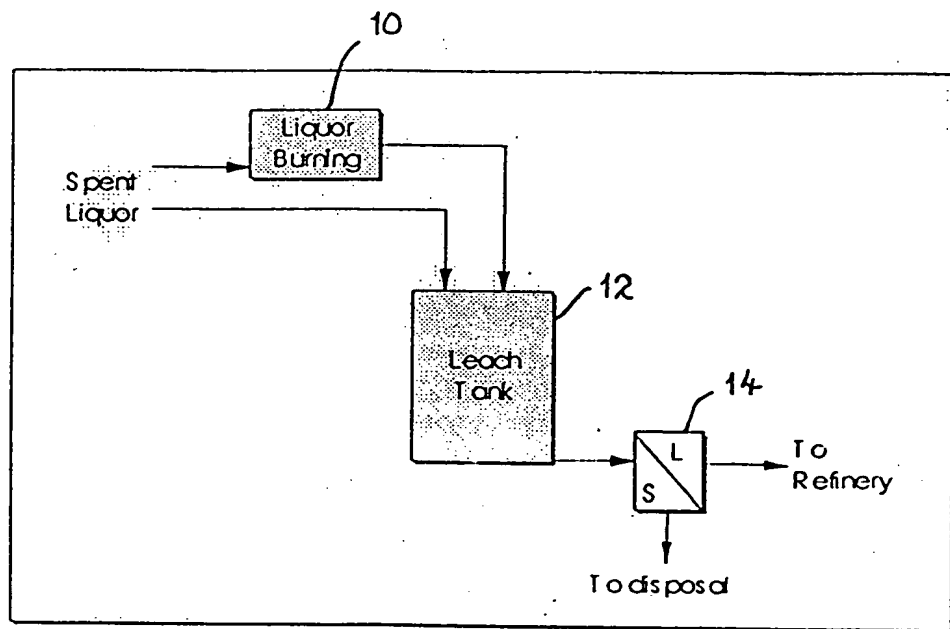


FIG. 1.

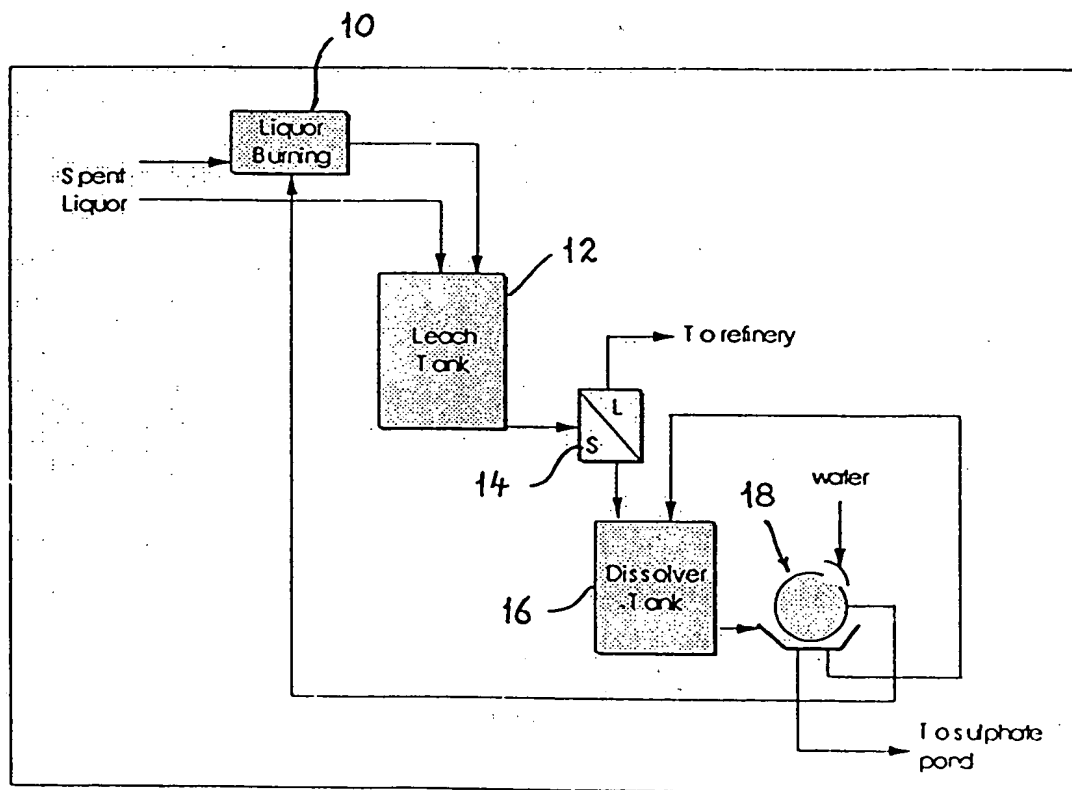


FIG. 2.



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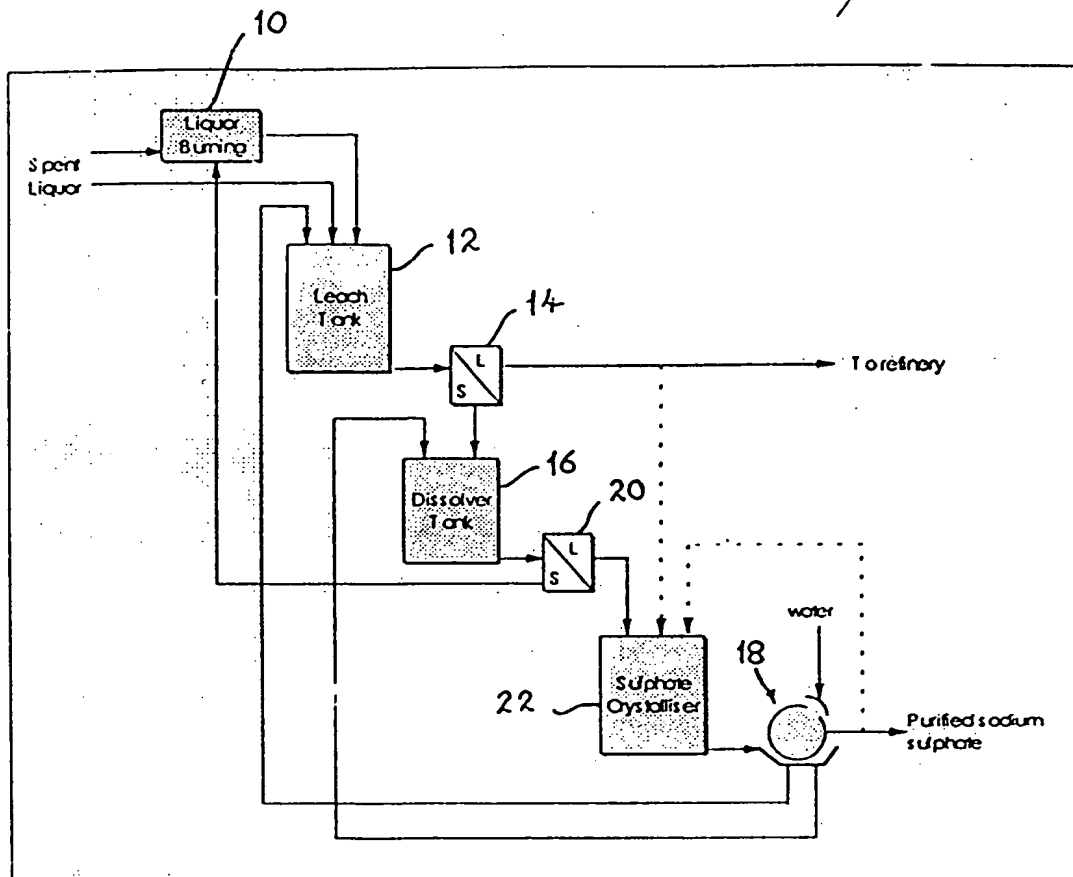


FIG. 3.

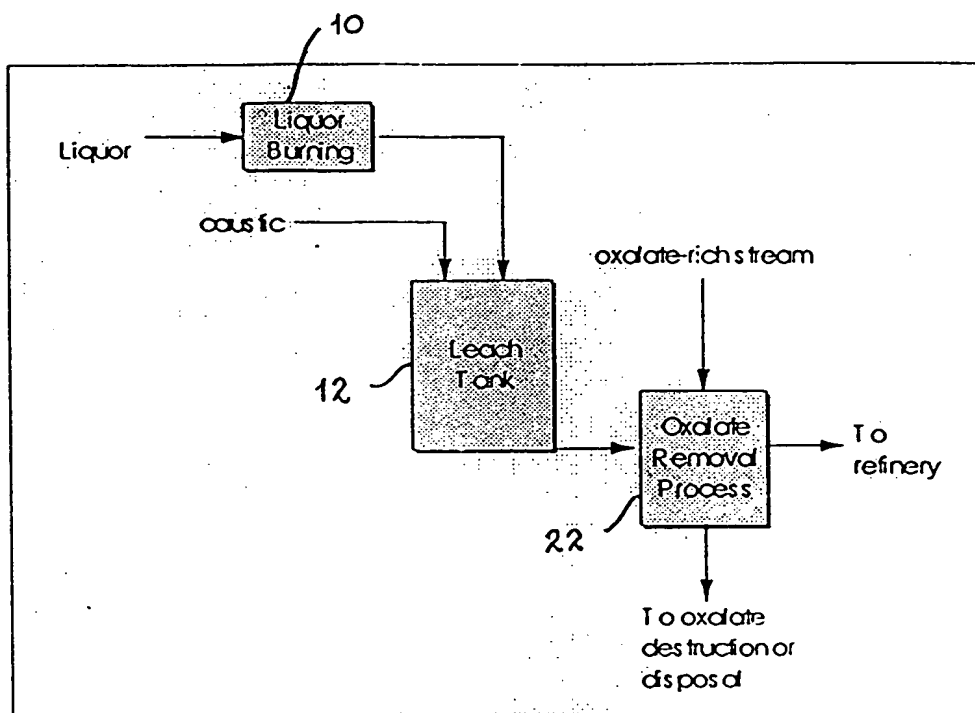


FIG. 4.

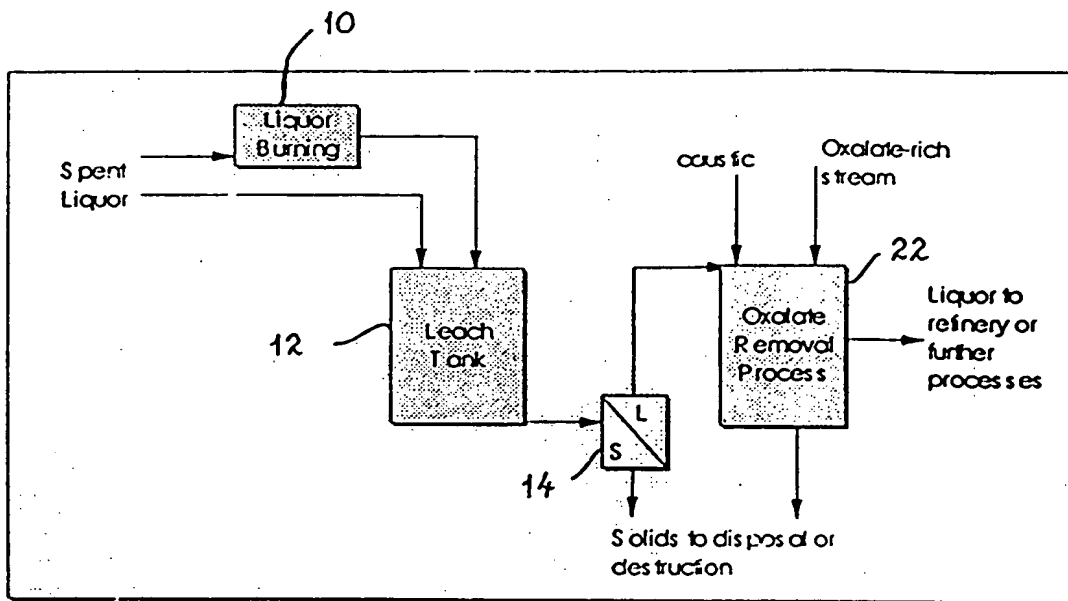


FIG. 5.

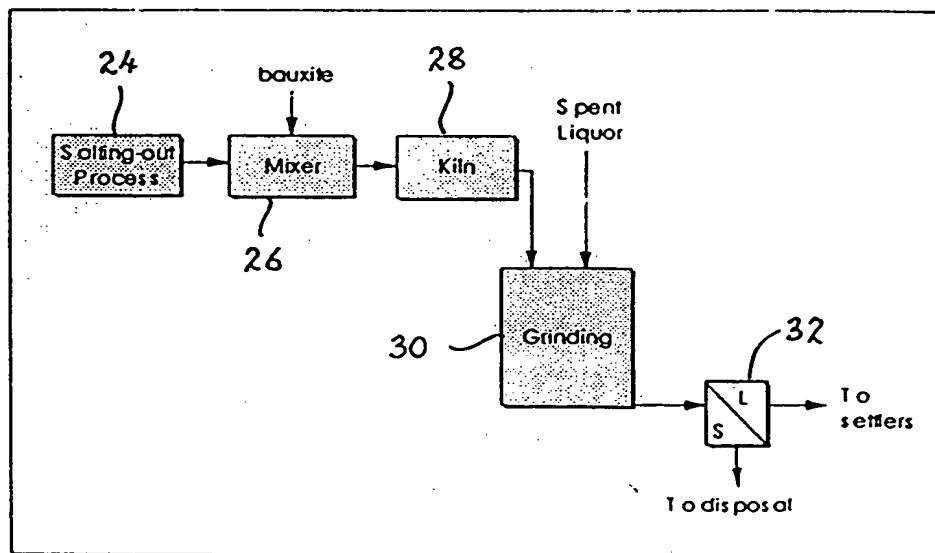


FIG. 6.